

CLAIMS

What is claimed is:

1. A repeater for use with an implantable neural system, the repeater comprising:

means for transmitting and receiving signals at a first frequency, wherein the first frequency is the frequency at which the implantable neural system is adapted to send and receive signals;

means for transmitting and receiving signals at a second frequency, wherein the second frequency is greater than the first frequency;

a first coil (42) through which signals of the first frequency may be received from and sent to the implantable neural stimulator;

an antenna (47) through which signals of the second frequency may be received from and sent to a remote unit, wherein the antenna is physically small; and

means for encoding and decoding signals of the first frequency to signals of the second frequency, and for encoding and decoding signals of the second frequency to the signals of the first frequency, whereby signals of the second frequency received through the antenna may be converted to signals of the first frequency that are coupled through the first coil to the implantable neural stimulator, and whereby signals of the first frequency received through the first coil may be converted to signals of the second frequency that are transmitted through the antenna and coupled to the remote unit.

2. The repeater of Claim 1 wherein the first frequency is about 10.7 MHz.

3. The repeater of Claim 1 wherein the second frequency is about 400 MHz.

4. The repeater of Claim 1 wherein the means for transmitting and receiving signals at the first frequency comprises a first receiver circuit (46) and a first transmitter circuit (44), each of which is coupled to the first coil (42).

5. The repeater of Claim 4 wherein the means for transmitting and receiving signals at the second frequency comprises a second receiver circuit (41) and a second transmitter circuit (43), each of which is coupled to the antenna (47).

6. The repeater of Claim 5 further including an antenna interface circuit (48), and wherein the antenna (47) is coupled to the second receiver circuit (41) and the second transmitter circuit (43) through the antenna interface circuit.

7. The repeater of Claim 6 further including holding means for temporarily holding the repeater and the first coil (42) in alignment with the implantable neural system.

8. The repeater of Claim 7 wherein the holding means comprises an ear hook adapted to fit over a user's ear, and wherein the repeater is mounted on the ear hook.

9. The repeater of Claim 7 wherein the holding means comprises a head strap adapted to fit over a user's head, and wherein the repeater is mounted on the head strap.

10. The repeater of Claim 7 wherein the holding means comprises a housing having a magnet therein, and wherein the magnet is adapted to magnetically engage with a magnetic member of the implantable neural system and to thereby hold the housing in place over the implantable neural system.

11. An implantable neural stimulator system comprising:

an implantable unit comprising an implanted receiving coil, circuitry for performing a specified function in accordance with programmed control signals, and means for receiving a first signal at a first frequency modulated with said programmed control signals through said implanted receiving coil;

a remote unit comprising means for generating the programmed control signals, a remote antenna, and transmitting means for transmitting an RF signal through the remote antenna at a second frequency modulated with the programmed control signals, wherein the second frequency is much greater than the first frequency;

a repeater comprising

means for transmitting signals at the first frequency,

means for receiving RF signals at the second frequency,

a first coil (42) through which signals of the first frequency may be sent to the implantable neural stimulator,

an antenna (47) through which signals of the second frequency may be received from the remote unit, wherein the antenna is physically small, and

means for demodulating received signals of the second frequency in order to recover the programmed control signals therefrom, and means for modulating the signal of the first frequency with the programmed control signals and presenting the modulated first frequency signal to the transmitting means,

whereby signals of the second frequency modulated with the programmed control signals and received through the antenna from the remote unit may be converted to signals of the first frequency modulated with the programmed control signals that are coupled through the first coil to the implantable neural stimulator;

whereby the programmed control signals, generated by the remote unit, may be transferred into the implantable neural stimulator by way of the repeater.

12. The implantable neural stimulator system of Claim 11 wherein the first frequency of the signal sent to the implantable neural stimulator through the first coil is about 10.7 MHz, and wherein the second frequency of the RF signal transmitted by the remote unit is about 400 MHz.

13. The implantable neural stimulator system of Claim 12 wherein the range over which a signal of the first frequency may be transmitted from the repeater to the implantable neural stimulator is less than about 5 inches.

14. The implantable neural stimulator system of Claim 12 wherein the range over which a signal of the second frequency may be transmitted from the remote unit to the repeater is about 200 feet.

15. The implantable neural stimulator system of Claim 11 wherein the remote unit further includes an input port through which externally-generated signals may be input and transmitted to the implantable neural stimulator through the repeater.

16. An implantable neural stimulator system comprising:

an implantable unit comprising an implanted coil, circuitry for performing a specified function in accordance with programmed control signals, means for sensing status information relating to the operation of the implantable unit; means for receiving a first signal of a first frequency modulated with said programmed control signals through said implanted coil, and means for transmitting a signal of the first frequency modulated with the status information through said implanted coil;

a remote unit comprising means for generating the programmed control signals, a remote antenna, transmitting means for transmitting an RF signal through the remote antenna at a second frequency modulated with the programmed control signals, receiver means for receiving an RF signal through the remote antenna at said second frequency modulated with the status information, and means for processing and displaying relevant information derived from the status information and programmed control signals, wherein the second frequency is much greater than the first frequency;

a repeater comprising

means for transmitting and receiving signals at the first frequency,

means for transmitting and receiving signals at the second frequency,

a first coil through which signals of the first frequency may be received from and sent to the implantable neural stimulator,

an antenna through which signals of the second frequency may be received from and sent to a remote unit, and

means for encoding and decoding signals of the first frequency to signals of the second frequency, and for encoding and decoding signals of the second frequency to the signals of the first frequency, whereby signals of the second frequency received through the antenna may be converted

to signals of the first frequency that are coupled through the first coil to the implantable neural stimulator, and whereby signals of the first frequency received through the first coil may be converted to signals of the second frequency that are transmitted through the antenna and coupled to the remote unit.

17. The implantable neural stimulation system of Claim 16 wherein the first frequency comprises a frequency of about 10.7 MHz, and wherein the second frequency comprises a frequency of about 400 MHz.

18. The implantable neural stimulation system of Claim 17 wherein signals received from the remote unit through the repeater antenna do not have exactly the same frequency as signals transmitted from the repeater through the repeater antenna to the remote unit.

19. The implantable neural stimulation system of Claim 18 wherein signals received from the remote unit through the repeater antenna have a frequency that is 410 MHz, and signals transmitted from the repeater through the repeater antenna to the remote unit have a frequency that is about 400 MHz.

20. The implantable neural stimulator system of Claim 16 wherein the range over which a signal of the first frequency may be transmitted from the repeater to the implantable neural stimulator is less than about 5 inches, and wherein the range over which a signal of the second frequency may be transmitted from the remote unit to the repeater is greater than 20 feet.